

GTE Command Reference

July 19, 1996

Version 1.0

Sony Computer Entertainment Inc.

Confidential

Limiters:

During some calculation processing, calculation results, data values in registers, etc., are clipped when they exceed specified upper limit and lower limit values. In other words, data values lower than the lower limit value are converted to the lower limit value, and data values higher than the upper limit value are converted to the upper limit value. Also, the occurrence of such conversions is reflected in out-of-bounds data detection flags in the FLAG register. These functions are referred to as "limters."

The usage of the various limters and the codes used to specify them in this documentation are listed below.

Calculation error detection:

Overflow and underflow detection are performed only for certain specific calculation operations. In this documentation, the calculation test result flag number is listed between angle brackets < > to the right of calculation operations that are subject to such detection.

Code	Limiter	Out-of-bounds detect bit	Lower limit	Upper limit	Comments
A1S	A1	24	-2 ¹⁵ 15	2 ¹⁵ -1	
A2S	A2	23	-2 ¹⁵ 15	2 ¹⁵ -1	
A3S	A3	22	-2 ¹⁵ 15	2 ¹⁵ -1	
A1U	A1	24	0	2 ¹⁵ -1	
A2U	A2	23	0	2 ¹⁵ -1	
A3U	A3	22	0	2 ¹⁵ -1	
A1C	A1	24	0 or -2 ¹⁵	2 ¹⁵ -1	Lower limit val is specified using lim argument.
A2C	A3	23	0 or -2 ¹⁵	2 ¹⁵ -1	Lower limit val is specified using lim argument.
A3C	A3	22	0 or -2 ¹⁵	2 ¹⁵ -1	Lower limit val is specified using lim argument.
B1	B1	21	0	2 ⁸ -1	
B2	B2	20	0	2 ⁸ -1	
B3	B3	19	0	2 ⁸ -1	
C	C	18	0	2 ¹⁶ -1	
D1	D1	14	-2 ¹⁰ 10	2 ¹⁰ -1	
D2	D2	13	-2 ¹⁰ 10	2 ¹⁰ -1	
E	E	12	0	2 ¹² -1	

Explanation:

Character attributes	Example	Content
Underline	VAL	Intermediate value (No corresponding register)
Emphasis character	OBJ	32-bit value

Descriptor examples:

(A) $A = B;$
--> $A=B$ is executed for the fixed-point expression (1.15.0).

(B)
(1.15.0) $IR0 = \text{limX}(SSX);$

Limiter:

Code	Lower limit	Upper limit
limX	-2 ¹⁵	2 ¹⁵ -1

--> The 32-bit value SSX is rounded using the limiter specified by X. The fixed-point expression (1.12.0) representing the results obtained is substituted for IR1.

(C)

$n=0,1,2\{$

(1.3.12)L1 n

= limA(LL1 n);

}

--

Argument value condition

Repeat the process between the curly parentheses {}

three times, substituting 0, 1, and 2 for n.

(a,b,c)

Fixed-point number

Sign portion: a bits, integer portion: b bits, fractional

portion: c bits

(-b,-)

b-bit binary data

Calculation subject to overflow and underflow testing

The test result is reflected in cumulative test flag n in the FLAG register.

(D)

$sf==0$ $sf==1$

(1.31.0) (1.19.12) $A = B;$

--> B is substituted for A. However, the value is converted into a 32-bit signed fixed-point number with no fractional part if sf is 0, and with a 12-bit fraction if sf is 1.

Command list:

Command details:
Command details are listed on the pages
which follow.

Command	Required cycles	Function
RTPS	14	Coordinate transformation & perspective transformation
RTPT	22	Coordinate transformation & perspective transformation
NCDS	19	Light source calculation
NCDT	44	Light source calculation
NCCS	17	Light source calculation
NCCT	39	Light source calculation
CDP	13	Light source calculation
CC	11	Light source calculation
NCS	14	Light source calculation
NCT	30	Light source calculation
MVMVA	8	Matrix calculation
DCPL	8	Depth cueing
INTPL	8	Interpolation
DPCS	8	Depth cueing
DPCT	17	Depth cueing
SQR	5	Vector squaring
AVSZ3	5	Z-averaging
AVSZ4	6	Z-averaging
NCLIP		Normal clipping
OP	6	Outer product
QPF	5	General purpose interpolation
GPL	5	General purpose interpolation

Function: Coordinate transformation and perspective transformation

Calculations:

$\text{SSX} = \text{TRX} + \text{R11}^*\text{VX0} + \text{R12}^*\text{VY0} + \text{R13}^*\text{VZ0}; <1>$
 $\text{SSY} = \text{TRY} + \text{R21}^*\text{VX0} + \text{R22}^*\text{VY0} + \text{R23}^*\text{VZ0}; <2>$
 $\text{SSZ} = \text{TRZ} + \text{R31}^*\text{VX0} + \text{R32}^*\text{VY0} + \text{R33}^*\text{VZ0}; <3>$
 $\text{IR1} = \text{ImA1S}(\text{SSX});$
 $\text{IR2} = \text{ImA2S}(\text{SSY});$
 $\text{IR3} = \text{ImA3S}(\text{SSZ});$
 $\text{SX0}(0) \leftarrow \text{SZ0}(1) \leftarrow \text{SZ1}(2) \leftarrow \text{SZ2}(3) \leftarrow \text{ImC}(\text{SSZ});$
 $\text{SX} = \text{OFX} + \text{IR1}^*(\text{H/SZ}); <4>$
 $\text{SY} = \text{OFY} + \text{IR2}^*(\text{H/SZ}); <4>$
 $\text{P} = \text{DQB} + \text{DQA}^*(\text{H/SZ}); <4>$
 $\text{IR0} = \text{ImE}(\text{P})$
 $\text{SX0} \leftarrow \text{SX1} \leftarrow \text{SX2} \leftarrow \text{ImD1}(\text{SX});$
 $\text{SY0} \leftarrow \text{SY1} \leftarrow \text{SY2} \leftarrow \text{ImD2}(\text{SY});$
 $\text{MAC0} = \text{P};$
 $\text{MAC1} = \text{SSX};$
 $\text{MAC2} = \text{SSY};$
 $\text{MAC3} = \text{SSZ};$

Referenced registers:		Modified registers:	
Data	Control	Data	Control
0 VX0,VY0	FR1,FR2	0 VX0,VY0	R11,R12
1 VZ0	H13,R21	1 VZ0	R13,R21
2 VX1,VY1	H22,R23	2 VX1,VY1	R22,R23
3 VZ1	H31,H32	3 VZ1	R31,R32
4 VX2,VY2	H33	4 VX2,VY2	R33
5 VZ2	TRX	5 VZ2	TRX
6 RGB_CODE	IRV	6 RGB_CODE	TRY
7 OTZ	TRZ	7 OTZ	TRZ
8 IR0	L11,L12	8 IR0	L11,L12
9 IR1	L13,L21	9 IR1	L13,L21
10 IR2	L22,L23	10 IR2	L22,L23
11 IR3	L31,L32	11 IR3	L31,L32
12 SX0,SY0	L33	12 SX0,SY0	L33
13 SX1,SY1	RBK	13 SX1,SY1	RBK
14 SX2,SY2	QBK	14 SX2,SY2	QBK
15 SX2P,SY2P	BBK	15 SX2P,SY2P	BBK
16 SX0	LR1,LR2	16 SX0	LR1,LR2
17 SZ0(1)	LR3,LQ1	17 SZ0(1)	LR3,LQ1
18 SZ1(2)	LQ2,LQ3	18 SZ1(2)	LQ2,LQ3
19 SZ2(3)	LB1,LB2	19 SZ2(3)	LB1,LB2
20 R0 Q0 B0	LB3	20 R0 Q0 B0	LB3
21 R1 Q1 B1	RFC	21 R1 Q1 B1	RFC
22 R2 Q2 B2	QFC	22 R2 Q2 B2	QFC
23 BFC	BFC	23 BFC	BFC
24 MAC0	OFX	24 MAC0	OFX
25 MAC1	OPY	25 MAC1	OPY
26 MAC2	H	26 MAC2	H
27 MAC3	DQA	27 MAC3	DQA
28 IRQB	DQB	28 IRQB	DQB
29 ORQB	ZSF3	29 ORQB	ZSF3
30 DATA32	ZSF4	30 DATA32	ZSF4
31 LZC	FLAG	31 LZC	FLAG

Referenced registers:		Modified registers:	
Data	Control	Data	Control
0		0	
VX0,VY0	FR1,FR2	VX0,VY0	R11,R12
VZ0	H13,R21	VZ0	R13,R21
VX1,VY1	H22,R23	VX1,VY1	R22,R23
VZ1	H31,H32	VZ1	R31,R32
VX2,VY2	H33	VX2,VY2	R33
VZ2	TRX	VZ2	TRX
RGB_CODE	IRV	RGB_CODE	TRY
OTZ	TRZ	OTZ	TRZ
IR0	L11,L12	IR0	L11,L12
IR1	L13,L21	IR1	L13,L21
IR2	L22,L23	IR2	L22,L23
IR3	L31,L32	IR3	L31,L32
SX0,SY0	L33	SX0,SY0	L33
SX1,SY1	RBK	SX1,SY1	RBK
SX2,SY2	QBK	SX2,SY2	QBK
SX2P,SY2P	BBK	SX2P,SY2P	BBK
SX0	LR1,LR2	SX0	LR1,LR2
SZ0(1)	LR3,LQ1	SZ0(1)	LR3,LQ1
SZ1(2)	LQ2,LQ3	SZ1(2)	LQ2,LQ3
SZ2(3)	LB1,LB2	SZ2(3)	LB1,LB2
R0 Q0 B0	LB3	R0 Q0 B0	LB3
R1 Q1 B1	RFC	R1 Q1 B1	RFC
R2 Q2 B2	QFC	R2 Q2 B2	QFC
BFC	BFC	BFC	BFC
MAC0	OFX	MAC0	OFX
MAC1	OPY	MAC1	OPY
MAC2	H	MAC2	H
MAC3	DQA	MAC3	DQA
IRQB	DQB	IRQB	DQB
ORQB	ZSF3	ORQB	ZSF3
DATA32	ZSF4	DATA32	ZSF4
LZC	FLAG	LZC	FLAG

RIPI

Required cycles:22

Function: Coordinate transformation and perspective transformation_

Calculations:

n=0,1,2 {

(1.31.12) $SSXn = TRX + R11*VXn + R12*VYn + R13*VZn; <1>$
 (1.31.12) $SSYn = TRY + R21*VXn + R22*VYn + R23*VZn; <2>$
 (1.31.12) $SSZn = TRZ + R31*VXn + R32*VYn + R33*VZn; <3>$

(0.18. 0) $SZX(0) = SZ2(3);$
 (0.18. 0) $SZ0(1) = ImC(SSZ0);$
 (0.18. 0) $SZ0(2) = ImC(SSZ1);$
 (0.18. 0) $SZ0(3) = ImC(SSZ2);$
 (1.27.16) $SXn = OFX + IR1*(H/SZ n); <4>$
 (1.27.16) $SYn = OFY + IR2*(H/SZ n); <4>$
 (1.19.24) $P = DQB + DQA*(H/SZ2); <4>$
 (1. 3.12) $IR0 = ImE(P);$
 (1.15. 0) $SXn = ImD1(SXn);$
 (1.15. 0) $SYn = ImD2(SYn);$

}

(1.15. 0) $IR1 = ImA1S(SSX2);$
 (1.15. 0) $IR2 = ImA2S(SSY2);$
 (1.15. 0) $IR3 = ImA3S(SSZ2);$
 (1. 7.24) $MAC0 = P;$
 (1.31. 0) $MAC1 = SSX2;$
 (1.31. 0) $MAC2 = SSY2;$
 (1.31. 0) $MAC3 = SSZ2;$

Modified registers:

	Data	Control
0	VX0.VY0	R11.R12
1	VZ0	R13.R21
2	VX1.VY1	R22.R23
3	VZ1	R31.R32
4	VX2.VY2	R33.
5	VZ2	TRX
6	RGB_CODE	TRY
7	OTZ	TRZ
8	IR0	L11.L12
9	IR1	L13.L21
10	IR2	L22.L23
11	IR3	L31.L32
12	SX0.SY0	L33.
13	SX1.SY1	RBK
14	SX2.SY2	QBK
15	SX2P.SY2P	BBK
16	SZx(0)	LR1.LR2
17	SZ0(1)	LR3.LQ1
18	SZ1(2)	LQ2.LQ3
19	SZ2(3)	LB1.LB2
20	R0 Q0 B0	LB3.
21	R1 Q1 B1	REC
22	R2 Q2 B2	QFC
23	BFC	BFC
24	MAC0	OFX
25	MAC1	OPY
26	MAC2	H.
27	MAC3	DQA.
28	IRGB	DQB
29	ORG	ZSF3.
30	DATA32	ZSF4.
31	LZC	FLAG

	Data	Control
0	VX0.VY0	R11.R12
1	VZ0	R13.R21
2	VX1.VY1	R22.R23
3	VZ1	R31.R32
4	VX2.VY2	R33.
5	VZ2	TRX
6	RGB_CODE	TRY
7	OTZ	TRZ
8	IR0	L11.L12
9	IR1	L13.L21
10	IR2	L22.L23
11	IR3	L31.L32
12	SX0.SY0	L33.
13	SX1.SY1	RBK
14	SX2.SY2	QBK
15	SX2P.SY2P	BBK
16	SZx(0)	LR1.LR2
17	SZ0(1)	LR3.LQ1
18	SZ1(2)	LQ2.LQ3
19	SZ2(3)	LB1.LB2
20	R0 Q0 B0	LB3.
21	R1 Q1 B1	REC
22	R2 Q2 B2	QFC
23	BFC	BFC
24	MAC0	OFX
25	MAC1	OPY
26	MAC2	H.
27	MAC3	DQA.
28	IRGB	DQB
29	ORG	ZSF3.
30	DATA32	ZSF4.
31	LZC	FLAG

NCDS

Required cycles:19

Function: Light source calculation

Calculations:

```

(1.19.24) LL1 = L11*VX0 + L12*VY0 + L13*VZ0; <1>
(1.19.24) LL2 = L21*VX0 + L22*VY0 + L23*VZ0; <2>
(1.19.24) LL3 = L31*VX0 + L32*VY0 + L33*VZ0; <3>
(1. 3.12) L1 = |lmA1U(LL1);
(1. 3.12) L2 = |lmA2U(LL2);
(1. 3.12) L3 = |lmA3U(LL3);
(1.19.24) RBLT = RBK + LR1*L1 + LR2*L2 + LR3*L3; <1>
(1.19.24) QBLT = QBK + LG1*L1 + LG2*L2 + LG3*L3; <2>
(1.19.24) BBLT = BBK + LB1*L1 + LB2*L2 + LB3*L3; <3>
(1. 3.12) RLT = |lmA1U(RBLT);
(1. 3.12) GLT = |lmA2U(QBLT);
(1. 3.12) BLT = |lmA3U(BBLT);
(1.27.16) RR0 = R*RLT + IR0*|lmA1S(RFC - R*RLT); <1>
(1.27.16) QQ0 = G*GLT + IR0*|lmA2S(QFC - G*GLT); <2>
(1.27.16) BB0 = B*BLT + IR0*|lmA3S(BFC - B*BLT); <3>
(1.11. 4) IR1 = |lmA1U(RR0);
(1.11. 4) IR2 = |lmA2U(QQ0);
(1.11. 4) IR3 = |lmA3U(BB0);
(-, 8,-) CD0 <- CD1 <- CD2 <- CODE
(0, 8, 0) R0 <- R1 <- R2 <- |lmB1(RR0);
(0, 8, 0) G0 <- G1 <- G2 <- |lmB2(QQ0);
(0, 8, 0) B0 <- B1 <- B2 <- |lmB3(BB0);
(1.27. 4) MAC1 = RR0;
(1.27. 4) MAC2 = QQ0;
(1.27. 4) MAC3 = BB0;

```

Referenced registers:		Modified registers:	
Data	Control	Data	Control
0 VX0,VY0	R11,R12	0 VX0,VY0	R11,R12
1 VZ0	R13,R21	1 VZ0	R13,R21
2 VX1,VY1	R22,R23	2 VX1,VY1	R22,R23
3 VZ1	R31,R32	3 VZ1	R31,R32
4 VX2,VY2	R33,	4 VX2,VY2	R33,
5 VZ2	TRX	5 VZ2	TRX
6 RGB CODE	TRY	6 RGB CODE	TRY
7 OTZ	TRZ	7 OTZ	TRZ
8 IR0	L11,L12	8 IR0	L11,L12
9 IR1	L13,L21	9 IR1	L13,L21
10 IR2	L22,L23	10 IR2	L22,L23
11 IR3	L31,L32	11 IR3	L31,L32
12 SX0,SY0	L33,	12 SX0,SY0	L33,
13 SX1,SY1	RBK	13 SX1,SY1	RBK
14 SX2,SY2	QBK	14 SX2,SY2	QBK
15 SX2P,SY2P	BBK	15 SX2P,SY2P	BBK
16 SXz(0)	LR1,LR2	16 SXz(0)	LR1,LR2
17 SZ0(1)	LR3,LQ1	17 SZ0(1)	LR3,LQ1
18 SZ1(2)	LQ2,LQ3	18 SZ1(2)	LQ2,LQ3
19 SZ2(3)	LB1,LB2	19 SZ2(3)	LB1,LB2
20 R0 Q0 B0	LB3,	20 R0 Q0 B0	LB3,
21 R1 Q1 B1	RFC	21 R1 Q1 B1	RFC
22 R2 Q2 B2	QFC	22 R2 Q2 B2	QFC
23 BFC		23 BFC	
24 MAC0	OFX	24 MAC0	OFX
25 MAC1	OPY	25 MAC1	OPY
26 MAC2	H,	26 MAC2	H,
27 MAC3	DQA,	27 MAC3	DQA,
28 IRQB	DQB	28 IRQB	DQB
29 ORQB	ZSF3,	29 ORQB	ZSF3,
30 DATA32	ZSF4,	30 DATA32	ZSF4,
31 L2C	FLAG	31 L2C	FLAG

Referenced registers:		Modified registers:	
Data	Control	Data	Control
0 VX0,VY0	R11,R12	0 VX0,VY0	R11,R12
1 VZ0	R13,R21	1 VZ0	R13,R21
2 VX1,VY1	R22,R23	2 VX1,VY1	R22,R23
3 VZ1	R31,R32	3 VZ1	R31,R32
4 VX2,VY2	R33,	4 VX2,VY2	R33,
5 VZ2	TRX	5 VZ2	TRX
6 RGB CODE	TRY	6 RGB CODE	TRY
7 OTZ	TRZ	7 OTZ	TRZ
8 IR0	L11,L12	8 IR0	L11,L12
9 IR1	L13,L21	9 IR1	L13,L21
10 IR2	L22,L23	10 IR2	L22,L23
11 IR3	L31,L32	11 IR3	L31,L32
12 SX0,SY0	L33,	12 SX0,SY0	L33,
13 SX1,SY1	RBK	13 SX1,SY1	RBK
14 SX2,SY2	QBK	14 SX2,SY2	QBK
15 SX2P,SY2P	BBK	15 SX2P,SY2P	BBK
16 SXz(0)	LR1,LR2	16 SXz(0)	LR1,LR2
17 SZ0(1)	LR3,LQ1	17 SZ0(1)	LR3,LQ1
18 SZ1(2)	LQ2,LQ3	18 SZ1(2)	LQ2,LQ3
19 SZ2(3)	LB1,LB2	19 SZ2(3)	LB1,LB2
20 R0 Q0 B0	LB3,	20 R0 Q0 B0	LB3,
21 R1 Q1 B1	RFC	21 R1 Q1 B1	RFC
22 R2 Q2 B2	QFC	22 R2 Q2 B2	QFC
23 BFC		23 BFC	
24 MAC0	OFX	24 MAC0	OFX
25 MAC1	OPY	25 MAC1	OPY
26 MAC2	H,	26 MAC2	H,
27 MAC3	DQA,	27 MAC3	DQA,
28 IRQB	DQB	28 IRQB	DQB
29 ORQB	ZSF3,	29 ORQB	ZSF3,
30 DATA32	ZSF4,	30 DATA32	ZSF4,
31 L2C	FLAG	31 L2C	FLAG

NCDT Required cycles:44

Referenced registers:		
	Data	Control
0	VX0.VY0	R11.R12
1	VZ0	R13.R21
2	VX1.VY1	R22.R23
3	VZ1	R31.R32
4	VX2.VY2	R33.
5	VZ2	TRX
6	RGB CODE	TRY
7	OTZ	TRZ
8	IR0	L11.L12
9	IR1	L13.L21
10	IR2	L22.L23
11	IR3	L31.L32
12	SX0.SY0	L33.
13	SX1.SY1	RBK
14	SX2.SY2	GBK
15	SX2P.SY2P	BBK
16	SZx0	Lx1.Lx2
17	SZ0(1)	Lx3.Lx1
18	SZ1(2)	Lx2.Lx3
19	SZ2(3)	LB1.LB2
20	RO GO BO	LB3.
21	R1 Q1 B1	RFC
22	R2 Q2 B2	QFC
23	BFC	BFC
24	MAC0 OFX	MAC0 OFX
25	MAC1 OPY	MAC1 OPY
26	MAC2 H.	MAC2 H.
27	MAC3 DQA.	MAC3 DQA.
28	RGB DQB	DQB
29	ORG B ZSF3,	ORG B ZSF3,
30	DATA32 ZSF4,	DATA32 ZSF4,
31	LZC FLAG	FLAG

Modified registers:

	Data	Control
0	VX0.VY0	R11.R12
1	VZ0	R13.R21
2	VX1.VY1	R22.R23
3	VZ1	R31.R32
4	VX2.VY2	R33.
5	VZ2	TRX
6	RGB CODE	TRY
7	OTZ	TRZ
8	IR0	L11.L12
9	IR1	L13.L21
10	IR2	L22.L23
11	IR3	L31.L32
12	SX0.SY0	L33.
13	SX1.SY1	RBK
14	SX2.SY2	GBK
15	SX2P.SY2P	BBK
16	SZx0	Lx1.Lx2
17	SZ0(1)	Lx3.Lx1
18	SZ1(2)	Lx2.Lx3
19	SZ2(3)	LB1.LB2
20	RO GO BO	LB3.
21	R1 Q1 B1	RFC
22	R2 Q2 B2	QFC
23	BFC	BFC
24	MAC0 OFX	MAC0 OFX
25	MAC1 OPY	MAC1 OPY
26	MAC2 H.	MAC2 H.
27	MAC3 DQA.	MAC3 DQA.
28	RGB DQB	DQB
29	ORG B ZSF3,	ORG B ZSF3,
30	DATA32 ZSF4,	DATA32 ZSF4,
31	LZC FLAG	FLAG

Calculations:

n=0,1,2 {

(1.19.24) $LL1n = L11*VXn + L12*Vyn + L13*VZn; <1>$

(1.19.24) $LL2n = L21*VXn + L22*Vyn + L23*VZn; <2>$

(1.19.24) $LL3n = L31*VXn + L32*Vyn + L33*VZn; <3>$

(1. 3.12) $L1n = \text{limA1U(LL1n);}$

(1. 3.12) $L2n = \text{limA2U(LL2n);}$

(1. 3.12) $L3n = \text{limA3U(LL3n);}$

(1.19.24) $BB1Tn = RBK + LR1*L1n + LR2*L2n + LR3*L3n; <1>$

(1.19.24) $QQ1Tn = QBK + LG1*L1n + LG2*L2n + LG3*L3n; <2>$

(1.19.24) $BB1Tn = BBK + LB1*L1n + LB2*L2n + LB3*L3n; <3>$

(1. 3.12) $RLTn = \text{limA1U(RRLTn);}$

(1. 3.12) $GLTn = \text{limA2U(GLLTn);}$

(1. 3.12) $BLTn = \text{limA3U(BBLTn);}$

(1.27.16) $BBn = R*RLTn + IR0*\text{limA1S(RFC - R*RLTn); <1>}$

(1.27.16) $QQn = G*GLTn + IR0*\text{limA2S(GFC - G*GLTn); <2>}$

(1.27.16) $BBn = B*BLTn + IR0*\text{limA3S(BFC - B*BLTn); <3>}$

(-. 8. -) $CDn = \text{CODE}$

(-. 8. 0) $Rn = \text{limB1(RBn); Gn = limB2(QGn);}$

(-. 8. 0) $Bn = \text{limB3(BBn);}$

}

(1.11. 4) $IR1 = \text{limA1U(RR2);}$

(1.11. 4) $IR2 = \text{limA2U(QQ2);}$

(1.11. 4) $IR3 = \text{limA3U(BB2);}$

(1.27. 4) $MAC1 = BB2;$

(1.27. 4) $MAC2 = QQ2;$

(1.27. 4) $MAC3 = BB2;$

Required cycles: 17

Function: Light source calculation

Calculations:

```

(1.19.24) LL1 = L11*VX0 + L12*VY0 + L13*VZ0; <1>
(1.19.24) LL2 = L21*VX0 + L22*VY0 + L23*VZ0; <2>
(1.19.24) LL3 = L31*VX0 + L32*VY0 + L33*VZ0; <3>
(1. 3.12) L1 = lma(LL1);
(1. 3.12) L2 = lma(LL2);
(1. 3.12) L3 = lma(LL3);
(1.19.24) RBLT = RBK + LR1*L1 + LR2*L2 + LR3*L3; <1>
(1.19.24) QBLT = QBK + LG1*L1 + LG2*L2 + LG3*L3; <2>
(1.19.24) BBLT = BBK + LB1*L1 + LB2*L2 + LB3*L3; <3>
(1. 3.12) RLT = lma1U(BBLT);
(1. 3.12) GLT = lma2U(QBLT);
(1. 3.12) BLT = lma3U(BBLT);
(1.27.16) BB0 = R*RLT; <1>
(1.27.16) QQ0 = G*GLT; <2>
(1.27.16) BB0 = B*BBLT; <3>
(1.1. 4) IR1 = lma1U(BB0);
(1.1. 4) IR2 = lma2U(QQ0);
(1.1. 4) IR3 = lma3U(BB0);
(-. 8. -) CD0 <- CD1 <- CD2 <- CODE
(0. 8. 0) R0 <- R1 <- R2 <- lmb1(BB0);
(0. 8. 0) G0 <- G1 <- G2 <- lmb2(QQ0);
(0. 8. 0) B0 <- B1 <- B2 <- lmb3(BB0);
(1.27. 4) MAC1 = BB0;
(1.27. 4) MAC2 = QQ0;
(1.27. 4) MAC3 = BB0;

```

Referenced registers:		Modified registers:	
Data	Control	Data	Control
0 VX0.VY0	R11.R12	0 VX0.VY0	R11.R12
1 VZ0	R13.R21	1 VZ0	R13.R21
2 VX1.VY1	R22.R23	2 VX1.VY1	R22.R23
3 VZ1	R31.R32	3 VZ1	R31.R32
4 VX2.VY2	R33.	4 VX2.VY2	R33.
5 VZ2	TRX	5 VZ2	TRX
6 RGB_CODE	TRY	6 RGB_CODE	TRY
7 OTZ	TRZ	7 OTZ	TRZ
8 IR0	L11.L12	8 IR0	L11.L12
9 IR1	L13.L21	9 IR1	L13.L21
10 IR2	L22.L23	10 IR2	L22.L23
11 IR3	L31.L32	11 IR3	L31.L32
12 SX0.SY0	L33.	12 SX0.SY0	L33.
13 SX1.SY1	RBK	13 SX1.SY1	RBK
14 SX2.SY2	QBK	14 SX2.SY2	QBK
15 SX2P.SY2P	BBK	15 SX2P.SY2P	BBK
16 SZx0	LB1.LB2	16 SZx0	LB1.LB2
17 SZ0(1)	LR3.LQ1	17 SZ0(1)	LR3.LQ1
18 SZ1(2)	LQ2.LQ3	18 SZ1(2)	LQ2.LQ3
19 SZ2(3)	LB1.LB2	19 SZ2(3)	LB1.LB2
20 R0.G0.B0	LB3.	20 R0.G0.B0	LB3.
21 R1.Q1.B1	RFC	21 R1.Q1.B1	RFC
22 R2.Q2.B2	QFC	22 R2.Q2.B2	QFC
23 BFC		23 BFC	
24 MAC0	OFX	24 MAC0	OFX
25 MAC1	OPY	25 MAC1	OPY
26 MAC2	H.	26 MAC2	H.
27 MAC3	DQA.	27 MAC3	DQA.
28 IRQB	DQB	28 IRQB	DQB
29 ORQB	ZSF3.	29 ORQB	ZSF3.
30 DATA32	ZSF4.	30 DATA32	ZSF4.
31 LZC	FLAG	31 LZC	FLAG

Referenced registers:		Modified registers:	
Data	Control	Data	Control
0		0	
1		1	
2		2	
3		3	
4		4	
5		5	
6		6	
7		7	
8		8	
9		9	
10		10	
11		11	
12		12	
13		13	
14		14	
15		15	
16		16	
17		17	
18		18	
19		19	
20		20	
21		21	
22		22	
23		23	
24		24	
25		25	
26		26	
27		27	
28		28	
29		29	
30		30	
31		31	

NCCT Required cycles: 39

Function: Light source calculation

Calculations:

```

n=0,1,2 {
  (1.19.24) L1n = L11*VXn + L12*VYn + L13*VZn; <1>
  (1.19.24) L2n = L21*VXn + L22*VYn + L23*VZn; <2>
  (1.19.24) L3n = L31*VXn + L32*VYn + L33*VZn; <3>
  (1. 3.12) L1n = lma1U(LL1n);
  (1. 3.12) L2n = lma2U(LL2n);
  (1. 3.12) L3n = lma3U(LL3n);
  (1.19.24) RRLTn = RBK + LR1*L1n + LR2*L2n + LR3*L3n; <1>
  (1.19.24) QQLTn = QBK + LG1*L1n + LG2*L2n + LG3*L3n; <2>
  (1.19.24) BBLTn = BBK + LB1*L1n + LB2*L2n + LB3*L3n; <3>
  (1. 3.12) RLTn = lma1U(BBLTn);
  (1. 3.12) GLTn = lma2U(QQLTn);
  (1. 3.12) BLTn = lma3U(BBLTn);
  (1.27.16) BBN = R*RLTn; <1>
  (1.27.16) QGN = G*GLTn; <2>
  (1.27.16) BBN = B*BLTn; <3>
  (-. 8. -) CDn = CODE
  (0. 8. 0) Rn = lmb1(BBn);
  (0. 8. 0) Gn = lmb2(QGn);
  (0. 8. 0) Bn = lmb3(BBn);
}

(1.11. 4) IR1 = lma1U(BB2); IR2 = lma2U(QG2);
(1.11. 4) IR3 = lma3U(BB2);
(1.27. 4) MAC1 = BB2; MAC2 = QG2;
(1.27. 4) MAC3 = BB2;
}

```

Required cycles: 39

Referenced registers:

	Data	Control
0	VX0.VY0	R11.R12
1	VZ0	R13.R21
2	VX1.VY1	R22.R23
3	VZ1	R31.R32
4	VX2.VY2	R33.
5	TRX	
6	RGB CODE	TRY
7	OTZ	TRZ
8	IR0	L11.L12
9	IR1	L13.L21
10	IR2	L22.L23
11	IR3	L31.L32
12	SX0.SY0	L33.
13	SX1.SY1	RBK
14	SX2.SY2	GBK
15	SX2P.SY2P	BBK
16	SZx0	LR1.LR2
17	SZ0(1)	LR3.LQ1
18	SZ1(2)	LG2.LG3
19	SZ2(3)	LB1.LB2
20	RO GO BO	
21	R1 Q1 B1	RFC
22	R2 Q2 B2	GFC
23	BFC	
24	MAC0	OFX
25	MAC1	OPY
26	MAC2	H.
27	MAC3	DQA.
28	IRGB	DQB
29	ORGB	ZSF3.
30	DATA32	ZSF4.
31	LZC	FLAG

Modified registers:

	Data	Control
0	VX0.VY0	R11.R12
1	VZ0	R13.R21
2	VX1.VY1	R22.R23
3	VZ1	R31.R32
4	VX2.VY2	R33.
5	VZ2	TRX
6	RGB CODE	TRY
7	OTZ	TRZ
8	IR0	L11.L12
9	IR1	L13.L21
10	IR2	L22.L23
11	IR3	L31.L32
12	SX0.SY0	L33.
13	SX1.SY1	RBK
14	SX2.SY2	GBK
15	SX2P.SY2P	BBK
16	SZx0	LR1.LR2
17	SZ0(1)	LR3.LQ1
18	SZ1(2)	LG2.LG3
19	SZ2(3)	LB1.LB2
20	RO GO BO	
21	H1 Q1 B1	RFC
22	H2 Q2 B2	GFC
23	BFC	
24	MAC0	OFX
25	MAC1	OPY
26	MAC2	H.
27	MAC3	DQA.
28	IRGB	DQB
29	ORGB	ZSF3.
30	DATA32	ZSF4.
31	LZC	FLAG

CDP **Required cycles: 13**

Function: Light source calculation

Calculations:

```

(1.19.24) RBLT = RBK + LR1*IR1 + LR2*IR2 + LR3*IR3; <1>
(1.19.24) QQLT = QBK + LG1*IR1 + LG2*IR2 + LG3*IR3; <2>
(1.19.24) BBLT = BBK + LB1*IR1 + LB2*IR2 + LB3*IR3; <3>
(1. 3.12) RLT = lma1U(BBLD);
(1. 3.12) GLT = lma2U(QQLD);
(1. 3.12) BLT = lma3U(BBLD);
(1.27.16) BB0 = R*RLT + IR0*lma1S(RFC - R*RLT); <1>
(1.27.16) QQ0 = G*GLT + IR0*lma2S(QFC - G*GLT); <2>
(1.27.16) BB0 = B*BLT + IR0*lma3S(BFC - B*BLT); <3>
(1.11. 4) IR1 = lma1U(BB0);
(1.11. 4) IR2 = lma2U(QQ0);
(1.11. 4) IR3 = lma3U(BB0);
(-. 8. -) CD0 <- CD1 <- CD2 <- CODE
(0. 8. 0) R0 <- R1 <- R2 <- lmb1(BB0);
(0. 8. 0) G0 <- G1 <- G2 <- lmb2(QQ0);
(0. 8. 0) B0 <- B1 <- B2 <- lmb3(BB0);
(1.27. 4) MAC1 = BB0;
(1.27. 4) MAC2 = QQ0;
(1.27. 4) MAC3 = BB0;

```

Referenced registers:		Modified registers:	
	Data		Control
0	VX0.VY0	R11.R12	0 VX0.VY0
1	VZ0	R13.R21	1 VZ0
2	VX1.VY1	R22.R23	2 VX1.VY1
3	VZ1	R31.R32	3 VZ1
4	VX2.VY2	R33.	4 VX2.VY2
5	VZ2	TRX	5 VZ2
6	RGB_CODE	TRY	6 RGB_CODE
7	OTZ	TRZ	7 OTZ
8	IR0	L11.L12	8 IR0
9	IR1	L13.L21	9 IR1
10	IR2	L22.L23	10 IR2
11	IR3	L31.L32	11 IR3
12	SX0.SY0	L33.	12 SX0.SY0
13	SX1.SY1	RBK	13 SX1.SY1
14	SX2.SY2	QBK	14 SX2.SY2
15	SX2P.SY2P	BBK	15 SX2P.SY2P
16	SZx0	LR1.LR2	16 SZx0
17	SZ0(1)	LR3.LQ1	17 SZ0(1)
18	SZ1(2)	LQ2.LQ3	18 SZ1(2)
19	SZ2(3)	LB1.LB2	19 SZ2(3)
20	R0.Q0.B0	LB3.	20 R0.Q0.B0
21	R1.Q1.B1	RFC	21 R1.Q1.B1
22	R2.Q2.B2	QFC	22 R2.Q2.B2
23	BFC	BFC	23 BFC
24	MAC0	OFX	24 MAC0
25	MAC1	OPY	25 MAC1
26	MAC2	H.	26 MAC2
27	MAC3	DQA.	27 MAC3
28	IRQB	DQB	28 IRQB
29	ORG8	ZSF3.	29 ORG8
30	DATA32	ZSF4.	30 DATA32
31	LZC	FLAG	31 LZC

	Data		Control
0	VX0.VY0	R11.R12	0 VX0.VY0
1	VZ0	R13.R21	1 VZ0
2	VX1.VY1	R22.R23	2 VX1.VY1
3	VZ1	R31.R32	3 VZ1
4	VX2.VY2	R33.	4 VX2.VY2
5	VZ2	TRX	5 VZ2
6	RGB_CODE	TRY	6 RGB_CODE
7	OTZ	TRZ	7 OTZ
8	IR0	L11.L12	8 IR0
9	IR1	L13.L21	9 IR1
10	IR2	L22.L23	10 IR2
11	IR3	L31.L32	11 IR3
12	SX0.SY0	L33.	12 SX0.SY0
13	SX1.SY1	RBK	13 SX1.SY1
14	SX2.SY2	QBK	14 SX2.SY2
15	SX2P.SY2P	BBK	15 SX2P.SY2P
16	SZx0	LR1.LR2	16 SZx0
17	SZ0(1)	LR3.LQ1	17 SZ0(1)
18	SZ1(2)	LQ2.LQ3	18 SZ1(2)
19	SZ2(3)	LB1.LB2	19 SZ2(3)
20	R0.Q0.B0	LB3.	20 R0.Q0.B0
21	R1.Q1.B1	RFC	21 R1.Q1.B1
22	R2.Q2.B2	QFC	22 R2.Q2.B2
23	BFC	BFC	23 BFC
24	MAC0	OFX	24 MAC0
25	MAC1	OPY	25 MAC1
26	MAC2	H.	26 MAC2
27	MAC3	DQA.	27 MAC3
28	IRQB	DQB	28 IRQB
29	ORG8	ZSF3.	29 ORG8
30	DATA32	ZSF4.	30 DATA32
31	LZC	FLAG	31 LZC

CC Required cycles: 11

Function: Light source calculation

Calculations:

```

(1.19.24) RBLT = RBK + LR1*IR1 + LR2*IR2 + LR3*IR3; <1>
(1.19.24) QGLT = QBK + LG1*IR1 + LG2*IR2 + LG3*IR3; <2>
(1.19.24) BBLT = BBK + LB1*IR1 + LB2*IR2 + LB3*IR3; <3>
(1.19.24) RLT = lma1U(RBLT);
(1. 3.12) GLT = lma2U(QGLT);
(1. 3.12) BLT = lma3U(BBLT);
(1. 3.12) RQ = R*RLT; <1>
(1.27.16) QQ = G*GLT; <2>
(1.27.16) BQ = B*BBLT; <3>
(1.27.16) IR1 = lma1U(RRQ);
(1.11. 4) IR2 = lma2U(QQ0);
(1.11. 4) IR3 = lma3U(BB0);
(1.11. 4) CD0 <- CD1 <- CD2 <- CODE
(0. 8. 0) R0 <- R1 <- R2 <- lmb1(BRQ);
(0. 8. 0) G0 <- G1 <- G2 <- lmb2(QQ0);
(0. 8. 0) B0 <- B1 <- B2 <- lmb3(BB0);
(1.27. 4) MAC1 = RRQ;
(1.27. 4) MAC2 = QQ0;
(1.27. 4) MAC3 = BB0;

```

Required cycles: 11

Referenced registers:

	Data	Control	
0	VX0.VY0	R11.R12	
1	VZ0	R13.R21	
2	VX1.VY1	R22.R23	
3	VZ1	R31.R32	
4	VX2.VY2	R33.	
5	VZ2	TRX	
6	RGB_CODE	TRY	
7	OTZ	TRZ	
8	IR0	L11.L12	
9	IR1	L13.L21	
10	IR2	L22.L23	
11	IR3	L31.L32	
12	SX0.SY0	L33.	
13	SX1.SY1	RBK	
14	SX2.SY2	GBK	
15	SX2P.SY2P	BBK	
16	S2x0	LR1.LR2	
17	S20(1)	LR3.LQ1	
18	S21(2)	LG2.LQ3	
19	S22(3)	LB1.LB2	
20	R0 Q0 B0	LB3.	
21	R1 Q1 B1	RFC	
22	R2 Q2 B2	QFC	
23	BFC	BFC	
24	MAC0	OFX	
25	MAC1	OPY	
26	MAC2	H.	
27	MAC3	DQA.	
28	IRQB	DQB	
29	ORG	ZSF3.	
30	DATA32	ZSF4.	
31	LZC	FLAG	

	Data	Control	
0	VX0.VY0	R11.R12	
1	VZ0	R13.R21	
2	VX1.VY1	R22.R23	
3	VZ1	R31.R32	
4	VX2.VY2	R33.	
5	VZ2	TRX	
6	RGB_CODE	TRY	
7	OTZ	TRZ	
8	IR0	L11.L12	
9	IR1	L13.L21	
10	IR2	L22.L23	
11	IR3	L31.L32	
12	SX0.SY0	L33.	
13	SX1.SY1	RBK	
14	SX2.SY2	GBK	
15	SX2P.SY2P	BBK	
16	S2x0	LR1.LR2	
17	S20(1)	LR3.LQ1	
18	S21(2)	LG2.LQ3	
19	S22(3)	LB1.LB2	
20	R0 Q0 B0	LB3.	
21	R1 Q1 B1	RFC	
22	R2 Q2 B2	QFC	
23	BFC	BFC	
24	MAC0	OFX	
25	MAC1	OPY	
26	MAC2	H.	
27	MAC3	DQA.	
28	IRQB	DQB	
29	ORG	ZSF3.	
30	DATA32	ZSF4.	
31	LZC	FLAG	

	Data	Control
0	VX0.VY0	R11.R12
1	VZ40	R13.R21
2	VX1.VY1	R22.R23
3	VZ1	R31.R32
4	VX2.VY2	R33.
5	VZ2	TRX
6	RGB_CODE	TRY
7	OTZ	TRY
8	IR0	L11.L12
9	IR1	L13.L21
10	IR2	L22.L23
11	IR3	L31.L32
12	SX0.SY0	L33.
13	SX1.SY1	RBK
14	SX2.SY2	QBK
15	SX2P.SY2P	BBK
16	SZx0	LR1.LR2
17	SZ0(1)	LR3.LQ1
18	SZ1(2)	LQ2.LQ3
19	SZ2(3)	LB1.LB2
20	R0.Q0.B0	LB3.
21	R1.Q1.B1	RFC
22	R2.Q2.B2	QFC
23	BFC	BFC
24	MAC0_OFX	OFX
25	MAC1_OPY	OPY
26	MAC2_H	H.
27	MAC3_DQA.	DQA.
28	IRQB_DQB	DQB
29	ORQB_ZSF3.	ZSF3.
30	DATA32_ZSF4.	ZSF4.
31	LZC_FLAG	FLAG

	Data	Control
0	VX0.VY0	R11.R12
1	VZ0	R13.R21
2	VX1.VY1	R22.R23
3	VZ1	R31.R32
4	VX2.VY2	R33.
5	VZ2	TRX
6	RGB_CODE	TRY
7	OTZ	TRY
8	IR0	L11.L12
9	IR1	L13.L21
10	IR2	L22.L23
11	IR3	L31.L32
12	SX0.SY0	L33.
13	SX1.SY1	RBK
14	SX2.SY2	QBK
15	SX2P.SY2P	BBK
16	SZx0	LR1.LR2
17	SZ0(1)	LR3.LQ1
18	SZ1(2)	LQ2.LQ3
19	SZ2(3)	LB1.LB2
20	R0.Q0.B0	LB3.
21	R1.Q1.B1	RFC
22	R2.Q2.B2	QFC
23	BFC	BFC
24	MAC0_OFX	OFX
25	MAC1_OPY	OPY
26	MAC2_H	H.
27	MAC3_DQA.	DQA.
28	IRQB_DQB	DQB
29	ORQB_ZSF3.	ZSF3.
30	DATA32_ZSF4.	ZSF4.
31	LZC_FLAG	FLAG

Function: Light source calculation

Calculations:

$LL1 = L11*VX0 + L12*VY0 + L13*VZ0; <1>$
 $LL2 = L21*VX0 + L22*VY0 + L23*VZ0; <2>$
 $LL3 = L31*VX0 + L32*VY0 + L33*VZ0; <3>$
 $L1 = \text{ImA1U}(LL1);$
 $L2 = \text{ImA2U}(LL2);$
 $L3 = \text{ImA3U}(LL3);$
 $RB0 = RBK + LR1*L1 + LR2*L2 + LR3*L3; <1>$
 $QB0 = QBK + LG1*L1 + LG2*L2 + LG3*L3; <2>$
 $BB0 = BBK + LB1*L1 + LB2*L2 + LB3*L3; <3>$
 $IR1 = \text{ImA1U}(RB0);$
 $IR2 = \text{ImA2U}(QB0);$
 $IR3 = \text{ImA3U}(BB0);$
 $CD0 \leftarrow CD1 \leftarrow CD2 \leftarrow \text{CODE}$
 $(-, 8, -)$
 $R0 \leftarrow R1 \leftarrow R2 \leftarrow \text{ImB1}(RB0);$
 $(0, 0, 8)$
 $G0 \leftarrow G1 \leftarrow G2 \leftarrow \text{ImB2}(QB0);$
 $(0, 0, 8)$
 $B0 \leftarrow B1 \leftarrow B2 \leftarrow \text{ImB3}(BB0);$
 $(1, 19, 12)$
 $MAC1 = RB0;$
 $MAC2 = QB0;$
 $MAC3 = BB0;$

NCT Required cycles: 30

Function: Light source calculation	
Calculations:	
n=0,1,2 {	
(1.19.24) $LL1n = L11^*VXn + L12^*VYn + L13^*VZn; <1>$	
(1.19.24) $LL2n = L21^*VXn + L22^*VYn + L23^*VZn; <2>$	
(1.19.24) $LL3n = L31^*VXn + L32^*VYn + L33^*VZn; <3>$	
(1. 3.12) $L1n = \text{ImA1U}(LL1n);$	
(1. 3.12) $L2n = \text{ImA2U}(LL2n);$	
(1. 3.12) $L3n = \text{ImA3U}(LL3n);$	
(1.19.24) $BB1n = RBK + LR1^*L1n + LR2^*L2n + LR3^*L3n; <1>$	
(1.19.24) $BB2n = RBK + LG1^*L1n + LG2^*L2n + LG3^*L3n; <2>$	
(1.19.24) $BB3n = BBK + LB1^*L1n + LB2^*L2n + LB3^*L3n; <3>$	
{. 8. -} $CDn = \text{CODE}$	
(0. 0. 8) $Rn = \text{ImB1}(BB1);$	
(0. 0. 8) $Gn = \text{ImB2}(BB2);$	
(0. 0. 8) $Bn = \text{ImB3}(BB3);$	
}	
(1. 3.12) $IR1 = \text{ImA1U}(BB2);$	
(1. 3.12) $IR2 = \text{ImA2U}(BB2);$	
(1. 3.12) $IR3 = \text{ImA3U}(BB2);$	
(1.19.12) $MAC1 = BB2;$	
(1.19.12) $MAC2 = BB2;$	
(1.19.12) $MAC3 = BB2;$	
(1. 3.12) $MAC0 = OFX;$	
25. $MAC1 = ORY;$	
26. $MAC2 = H;$	
27. $MAC3 = DQA;$	
28. $IRGB = DQB;$	
29. $ORG = ZSF3;$	
30. $DATA32 = ZSF4;$	
31. $LZC = FLAG;$	

Referenced registers:

Modified registers:	Data	Data	Control
0	VX0.VY0	0	R11.R12
1	VZ0	1	VZ0
2	VX1.VY1	2	VX1.VY1
3	VZ1	3	VZ1
4	VX2.VY2	4	VX2.VY2
5	VZ2	5	TRX
6	RGB	6	RGB CODE
7	OTZ	7	TRY
8	IR0	8	IR0
9	IR1	9	IR1
10	IR2	10	IR2
11	IR3	11	IR3
12	SX0.SY0	12	SX0.SY0
13	SX1.SY1	13	SX1.SY1
14	SX2.SY2	14	SX2.SY2
15	SX2P.SY2P	15	SX2P.SY2P
16	SZx(0)	16	BBK
17	SZ0(1)	17	BBK
18	SZ1(2)	18	SZ1(2)
19	SZ2(3)	19	SZ2(3)
20	R0.Q0.B0	20	R0.Q0.B0
21	R1.Q1.B1	21	R1.Q1.B1
22	R2.Q2.B2	22	R2.Q2.B2
23	BFC	23	BFC
24	MAC0	24	MAC0
25	MAC1	25	MAC1
26	MAC2	26	MAC2
27	MAC3	27	MAC3
28	IRGB	28	IRGB
29	ORG	29	ORG
30	DATA32	30	DATA32
31	LZC	31	FLAG

MVMVA.slmxx.vcvm

Required cycles: 8

Function: Matrix and vector multiplication

Items specified using arguments:

Argument	Specified content	Value=0	Value = 1	Value=2	Value = 3
sf	Scaling format	Scale large	Scale small	Not valid	Not valid
mx	Multiplication array (MX)	R	L	LR	Not valid
v	Multiplication vector (V)	Vp0 (1.m.n)	Vp1 p-X/Y/Z	Vp2 p-X/Y/Z	IRp p-0/1/2
cv	Addition vector (CV)	TRP (1.16+m. n)	PBK p-R/B/G	PFC p-R/B/G	0
lm	Limiter	-2^15	0	Not valid	Not valid
	A1/2/3 lower limit				

* Data formats

The multiplication matrix data format is fixed.
The other data formats are determined by the multiplication vector data format.

Calculations: (m and n are determined by the multiplication vector data format.)

(1.m-12,n+12) $MT1 = CV1 + MX11*V1 + MX12*V2 + MX13*V3; <1>$
 $MT2 = CV2 + MX21*V1 + MX22*V2 + MX23*V3; <2>$
 $MT3 = CV3 + MX31*V1 + MX32*V2 + MX33*V3; <3>$
 $MAC1 = MT1$
 $MAC2 = MT2$
 $MAC3 = MT3$

sf == 0 sf == 1

(1.m-12,n+12) (1.m,n) IR1 = lmA1C(MT1);
 $IR2 = lmA2C(MT2)$
 $IR3 = lmA3C(MT3)$

Referenced registers:	Modified registers:
Data	Control
VX0,VY0	R11,R12
VZ0	R13,R21
VX1,VY1	R22,R23
VZ1	R31,R32
VX2,VY2	R33,
VZ2	TRX
IR0	TRY
OTZ	TRZ
IR0	L11,L12
IR1	L13,L21
IR2	L22,L23
IR3	L31,L32
SX0,SY0	L33,
SX1,SY1	RBK
SX2,SY2	QBK
SX2P,SY2P	BBK
SZx0	LR1,LR2
SZ0(1)	LR3,LQ1
SZ1(2)	LQ2,LQ3
SZ2(3)	LB1,LB2
R0 G0 B0	LB3,
R1 Q1 B1	RFC
R2 Q2 B2	QFC
BFC	BFC
MAC0	OFX
MAC1	OPY
MAC2	H,
MAC3	DQA,
IRQB	DQB
ORQB	ZSF3,
DATA32	ZSF4,
L2C	FLAG

Referenced registers:	Modified registers:
Data	Control
VX0,VY0	R11,R12
VZ0	R13,R21
VX1,VY1	R22,R23
VZ1	R31,R32
VX2,VY2	R33,
VZ2	TRX
IR0	TRY
OTZ	TRZ
IR0	L11,L12
IR1	L13,L21
IR2	L22,L23
IR3	L31,L32
SX0,SY0	L33,
SX1,SY1	RBK
SX2,SY2	QBK
SX2P,SY2P	BBK
SZx0	LR1,LR2
SZ0(1)	LR3,LQ1
SZ1(2)	LQ2,LQ3
SZ2(3)	LB1,LB2
R0 G0 B0	LB3,
R1 Q1 B1	RFC
R2 Q2 B2	QFC
BFC	BFC
MAC0	OFX
MAC1	OPY
MAC2	H,
MAC3	DQA,
IRQB	DQB
ORQB	ZSF3,
DATA32	ZSF4,
L2C	FLAG

DCPL. Required cycles: 8

Function: Depth cueing

Calculations:

(1.27. 16) $RR0 = R^*IR1 + IR0^*ImA1S(RFC - R^*IR1); <1>$
 (1.27. 16) $QQ0 = G^*IR2 + IR0^*ImA2S(QFC - G^*IR2); <2>$
 (1.27. 16) $BB0 = B^*IR3 + IR0^*ImA3S(BFC - B^*IR3); <3>$
 (1.11. 4) $IR1 = ImA1S(RR0);$
 (1.11. 4) $IR2 = ImA2S(QQ0);$
 (1.11. 4) $IR3 = ImA3S(BB0);$
 (‐. 8. ‐) $CD0 \leftarrow CD1 \leftarrow CD2 \leftarrow CODE$
 (0. 8. 0) $Ro \leftarrow R1 \leftarrow R2 \leftarrow ImB1(RR0);$
 (0. 8. 0) $Go \leftarrow G1 \leftarrow G2 \leftarrow ImB2(QQ0);$
 (0. 8. 0) $Bo \leftarrow B1 \leftarrow B2 \leftarrow ImB3(BB0);$
 (1.27. 4) **MAC1 = RR0;**
 (1.27. 4) **MAC2 = QQ0;**
 (1.27. 4) **MAC3 = BB0;**

Referenced registers:

	Data	Control
0	VX0.VY0	R11.R12
1	VZ0	R13.R21
2	VX1.VY1	R22.R23
3	VZ1	R31.R32
4	VX2.VY2	R33.
5	VZ2	TRX
6	RGB_CODE	TRY
7	OTZ	TRZ
8	IR0	L11.L12
9	IR1	L13.L21
10	IR2	L22.L23
11	IR3	L31.L32
12	SX0.SY0	L33.
13	SX1.SY1	RBK
14	SX2.SY2	QBK
15	SX2P.SY2P	BBK
16	S2x(0)	LR1.LR2
17	SZ0(1)	LR3.LQ1
18	SZ1(2)	LQ2.LQ3
19	SZ2(3)	LB1.LB2
20	Ro.Q0.B0	LB3.
21	R1.Q1.B1	RFC
22	R2.Q2.B2	GFC
23	BFC	BFC
24	MAC0	QFX
25	MAC1	OPY
26	MAC2	H.
27	MAC3	DQA.
28	IRQB	DQB
29	ORQB	ZSF3.
30	DATA32	ZSF4.
31	L2C	FLAG

Modified registers:

	Data	Control
0	VX0.VY0	R11.R12
1	VZ0	R13.R21
2	VX1.VY1	R22.R23
3	VZ1	R31.R32
4	VX2.VY2	R33.
5	VZ2	TRX
6	RGB_CODE	TRY
7	OTZ	TRZ
8	IR0	L11.L12
9	IR1	L13.L21
10	IR2	L22.L23
11	IR3	L31.L32
12	SX0.SY0	L33.
13	SX1.SY1	RBK
14	SX2.SY2	QBK
15	SX2P.SY2P	BBK
16	S2x(0)	LR1.LR2
17	SZ0(1)	LR3.LQ1
18	SZ1(2)	LQ2.LQ3
19	SZ2(3)	LB1.LB2
20	Ro.Q0.B0	LB3.
21	R1.Q1.B1	RFC
22	R2.Q2.B2	GFC
23	BFC	BFC
24	MAC0	QFX
25	MAC1	OPY
26	MAC2	H.
27	MAC3	DQA.
28	IRQB	DQB
29	ORQB	ZSF3.
30	DATA32	ZSF4.
31	L2C	FLAG

INTPL

Referenced registers:

Referenced registers:		Modified registers:	
	Data		Control
0	VX0.VY0	R11.R12	0
1	VZ0	R13.R21	1
2	VX1.VY1	R22.R23	2
3	VZ1	R31.R32	3
4	VX2.VY2	R33.	4
5	VZ2	TRX	5
6	RQB COD	TRY	6
7	OTZ	TRZ	7
8	IR0	L11.L12	8
9	IR1	L13.L21	9
10	IR2	L22.L23	10
11	IR3	L31.L32	11
12	SX0.SY0	L33.	12
13	SX1.SY1	RBK	13
14	SX2.SY2	QBK	14
15	SX2P.SY2P	BBK	15
16	SZx0	LR1.LR2	16
17	SZ0(1)	LR3.LQ1	17
18	SZ1(2)	LQ2.LQ3	18
19	SZ2(3)	LB1.LB2	19
20	R0.Q0.B0	LB3.	20
21	R1.Q1.B1	RFC	21
22	R2.Q2.B2	GFC	22
23	BFC	BFC	23
24	MAC0	OFX	24
25	MAC1	OPY	25
26	MAC2	H.	26
27	MAC3	DQA.	27
28	IRQB	DQB	28
29	ORQB	ZSF3.	29
30	DATA32	ZSF4.	30
31	LZC	FLAG	31

Modified registers:

	Data		Control
0	VX0.VY0	R11.R12	0
1	VZ0	R13.R21	1
2	VX1.VY1	R22.R23	2
3	VZ1	R31.R32	3
4	VX2.VY2	R33.	4
5	VZ2	TRX	5
6	RQB CODE	TRY	6
7	OTZ	TRZ	7
8	IR0	L11.L12	8
9	IR1	L13.L21	9
10	IR2	L22.L23	10
11	IR3	L31.L32	11
12	SX0.SY0	L33.	12
13	SX1.SY1	RBK	13
14	SX2.SY2	QBK	14
15	SX2P.SY2P	BBK	15
16	SZx0	LR1.LR2	16
17	SZ0(1)	LR3.LQ1	17
18	SZ1(2)	LQ2.LQ3	18
19	SZ2(3)	LB1.LB2	19
20	R0.Q0.B0	LB3.	20
21	R1.Q1.B1	RFC	21
22	R2.Q2.B2	GFC	22
23	BFC	BFC	23
24	MAC0	OFX	24
25	MAC1	OPY	25
26	MAC2	H.	26
27	MAC3	DQA.	27
28	IRQB	DQB	28
29	ORQB	ZSF3.	29
30	DATA32	ZSF4.	30
31	LZC	FLAG	31

Required cycles: 8

Revised cycle: 8

Function: Depth cueing

Calculations:

(1.27.16) $RHQ = R^*1.0 + |R0|^2 \text{Im}A1S(RFC-R^*1.0); <1>$
 (1.27.16) $QG0 = G^*1.0 + |R0|^2 \text{Im}A2S(QFC-G^*1.0); <2>$
 (1.27.16) $BB0 = B^*1.0 + |R0|^2 \text{Im}A3S(BFC-B^*1.0); <3>$

(1.11. 4) $IR1 = \text{Im}A1S(BR0);$
 (1.11. 4) $IR2 = \text{Im}A2S(QG0);$
 (1.11. 4) $IR3 = \text{Im}A3S(BB0);$

(1.27.16) $CD0 \leftarrow CD1 \leftarrow CD2 \leftarrow \text{CODE}$
 (1.27.16) $R0 \leftarrow R1 \leftarrow R2 \leftarrow \text{Im}B1(BR0);$
 (1.27.16) $G0 \leftarrow G1 \leftarrow G2 \leftarrow \text{Im}B2(QG0);$
 (1.27.16) $B0 \leftarrow B1 \leftarrow B2 \leftarrow \text{Im}B3(BB0);$

(1.11. 4) $MAC1 = BR0;$
 (1.11. 4) $MAC2 = QG0;$
 (1.11. 4) $MAC3 = BB0;$

(1.27. 4) $R0 = R^*1.0 + |R0|^2 \text{Im}A1S(RFC-R^*1.0); <1>$
 (1.27. 4) $Q0 = G^*1.0 + |R0|^2 \text{Im}A2S(QFC-G^*1.0); <2>$
 (1.27. 4) $B0 = B^*1.0 + |R0|^2 \text{Im}A3S(BFC-B^*1.0); <3>$

Referenced registers:	Data	Control
0	VX0.VY0	R11.R12
1	VZ0	R13.R21
2	VX1.VY1	R22.R23
3	VZ1	R31.R32
4	VX2.VY2	R33.
5	VZ2	TRX
6	IRGB_code	TRY
7	OTZ	TRZ
8	IR0	L11.L12
9	IR1	L13.L21
10	IR2	L22.L23
11	IR3	L31.L32
12	SX0.SY0	L33.
13	SX1.SY1	RBK
14	SX2.SY2	GBK
15	SX2P.SY2P	BBK
16	SZx0	LR1.LR2
17	SZ0(1)	LR3.LG1
18	SZ1(2)	LG2.LG3
19	SZ2(3)	LB1.LB2
20	R0.G0.B0	LB3.
21	R1.G1.B1	HFC
22	R2.G2.B2	GFC
23		BFC
24	MAC0	OFX
25	MAC1	OPY
26	MAC2	H.
27	MAC3	DQA,
28	IRGB	DQB
29	ORGb	ZSF3,
30	DATA32	ZSF4,
31	LZC	FLAG

Modified registers:		Control	Control
	Data	R11.R12	R11.R12
0	VX0.VY0	R13.R21	R13.R21
1	VZ0	R22.R23	R22.R23
2	VX1.VY1	R31.R32	R31.R32
3	VZ1	R33.	R33.
4	VX2.VY2	TRX	TRX
5	VZ2	TRY	TRY
6	RQB CODE	TRY	TRY
7	OIZ	TRZ	TRZ
8	IR0	L11.L12	L11.L12
9	IR1	L13.L21	L13.L21
10	IR2	L22.L23	L22.L23
11	IR3	L31.L32	L31.L32
12	SX0.SY0	L33.	L33.
13	SX1.SY1	RBK	RBK
14	SX2.SY2	GBK	GBK
15	SX2P.SY2P	BBK	BBK
16	SZx0	LR1.LR2	LR1.LR2
17	SZ0(1)	LR3.LQ1	LR3.LQ1
18	SZ1(2)	LQ2.LQ3	LQ2.LQ3
19	SZ2(3)	LB1.LB2	LB1.LB2
20	RG0.B0	LB3.	LB3.
21	R1.G1.B1	RFC	RFC
22	R2.G2.B2	GFC	GFC
23		BFC	BFC
24	MAC0	OFX	OFX
25	MAC1	OPY	OPY
26	MAC2	H.	H.
27	MAC3	DQA.	DQA.
28	IRGB	DQB	DQB
29	ORGB	ZSF3.	ZSF3.
30	DATA32	ZSF4.	ZSF4.
31	LZC	FLAG	FLAG

DPCT _____ Required cycles: 17.

Function: Depth cueing

Calculations:

```

n=0,1,2 {
  (1.27,16) BBn = Rn*1.0 + IR0*limA1S(RFC-R*1.0); <1>
  (1.27,16) QQn = Gn*1.0 + IR0*limA2S(GFC-G*1.0); <2>
  (1.27,16) BBn = Bn*1.0 + IR0*limA3S(BFC-B*1.0); <3>
  (1.11, 4) IR1 = limA1S(BB2);
  (1.11, 4) IR2 = limA2S(QQ2);
  (1.11, 4) IR3 = limA3S(BB2);
  (-, 8,-) CDn = CODE;
  (0, 8, 0) Rn = limB1(BBn);
  (0, 8, 0) Gn = limB2(QQn);
  (0, 8, 0) Bn = limB3(BBn);
}

(1.27, 4) MAC1 = BB2;
(1.27, 4) MAC2 = QQ2;
(1.27, 4) MAC3 = BB2;
  
```

Referenced registers:		Modified registers:	
Data	Control	Data	Control
0 VX0.VY0	R11.R12	0 VX0.VY0	R11.R12
1 VZ0	R13.R21	1 VZ0	R13.R21
2 VX1.VY1	R22.R23	2 VX1.VY1	R22.R23
3 VZ1	R31.R32	3 VZ1	R31.R32
4 VX2.VY2	R33.	4 VX2.VY2	R33.
5 VZ2	TRX	5 VZ2	TRX
6 RGB_CODE TRY		6 RGB_CODE TRY	
7 OTZ	TRZ	7 OTZ	TRZ
8 IR0	L11.L12	8 IR0	L11.L12
9 IR1	L13.L21	9 IR1	L13.L21
10 IR2	L22.L23	10 IR2	L22.L23
11 IR3	L31.L32	11 IR3	L31.L32
12 SX0.SY0	L33.	12 SX0.SY0	L33.
13 SX1.SY1	RBK	13 SX1.SY1	RBK
14 SX2.SY2	GBK	14 SX2.SY2	GBK
15 SX2P.SY2P	BBK	15 SX2P.SY2P	BBK
16 SZx(0)	LB1.LB2	16 SZx(0)	LB1.LB2
17 SZ0(1)	LR3.LQ1	17 SZ0(1)	LR3.LQ1
18 SZ1(2)	LQ2.LQ3	18 SZ1(2)	LQ2.LQ3
19 SZ2(3)	LB1.LB2	19 SZ2(3)	LB1.LB2
20 R0.Q0.B0	LB3.	20 R0.Q0.B0	LB3.
21 R1.Q1.B1	RFC	21 R1.Q1.B1	RFC
22 R2.Q2.B2	GFC	22 R2.Q2.B2	GFC
23 BFC		23 BFC	
24 MAC0	OFX	24 MAC0	OFX
25 MAC1	OPY	25 MAC1	OPY
26 MAC2	H.	26 MAC2	H.
27 MAC3	DQA.	27 MAC3	DQA.
28 IRQB	DQB	28 IRQB	DQB
29 ORQB	ZSF3.	29 ORQB	ZSF3.
30 DATA32	ZSF4.	30 DATA32	ZSF4.
31 L2C	FLAG	31 L2C	FLAG

Referenced registers:		Modified registers:	
Data	Control	Data	Control
0 VX0.VY0	R11.R12	0 VX0.VY0	R11.R12
1 VZ0	R13.R21	1 VZ0	R13.R21
2 VX1.VY1	R22.R23	2 VX1.VY1	R22.R23
3 VZ1	R31.R32	3 VZ1	R31.R32
4 VX2.VY2	R33.	4 VX2.VY2	R33.
5 VZ2	TRX	5 VZ2	TRX
6 RGB_CODE TRY		6 RGB_CODE TRY	
7 OTZ	TRZ	7 OTZ	TRZ
8 IR0	L11.L12	8 IR0	L11.L12
9 IR1	L13.L21	9 IR1	L13.L21
10 IR2	L22.L23	10 IR2	L22.L23
11 IR3	L31.L32	11 IR3	L31.L32
12 SX0.SY0	L33.	12 SX0.SY0	L33.
13 SX1.SY1	RBK	13 SX1.SY1	RBK
14 SX2.SY2	GBK	14 SX2.SY2	GBK
15 SX2P.SY2P	BBK	15 SX2P.SY2P	BBK
16 SZx(0)	LB1.LB2	16 SZx(0)	LB1.LB2
17 SZ0(1)	LR3.LQ1	17 SZ0(1)	LR3.LQ1
18 SZ1(2)	LQ2.LQ3	18 SZ1(2)	LQ2.LQ3
19 SZ2(3)	LB1.LB2	19 SZ2(3)	LB1.LB2
20 R0.Q0.B0	LB3.	20 R0.Q0.B0	LB3.
21 R1.Q1.B1	RFC	21 R1.Q1.B1	RFC
22 R2.Q2.B2	GFC	22 R2.Q2.B2	GFC
23 BFC		23 BFC	
24 MAC0	OFX	24 MAC0	OFX
25 MAC1	OPY	25 MAC1	OPY
26 MAC2	H.	26 MAC2	H.
27 MAC3	DQA.	27 MAC3	DQA.
28 IRQB	DQB	28 IRQB	DQB
29 ORQB	ZSF3.	29 ORQB	ZSF3.
30 DATA32	ZSF4.	30 DATA32	ZSF4.
31 L2C	FLAG	31 L2C	FLAG

SQR.SI

Required cycles: 5

Function: Vector squaring

Items specified using arguments:

Argument	Specified content	Value = 0	Value = 1
sI	Output format	-	Performs calculations on data shifted 12 bits to the left in the IRn register.

Calculations: (m and n request the data format of IRp(p=1,2,3) as

```
(1.m.n.)
sf == 0      sf == 1
(1.m+28.n)  (1.m+16.n+12)  L1 = IR1*IR1; <1>
(1.m+28.n)  (1.m+16.n+12)  L2 = IR2*IR2; <2>
(1.m+28.n)  (1.m+16.n+12)  L3 = IR3*IR3; <3>
(1.m    .n)  (1.m+16.n+12)  IR1 = lma1U(L1);
(1.m    .n)  (1.m+16.n+12)  IR2 = lma2U(L2);
(1.m    .n)  (1.m+16.n+12)  IR3 = lma3U(L3);
(1.m+16.0)  (1.m+8.n+12)   MAC1 = L1;
(1.m+16.0)  (1.m+16.n+12)  MAC2 = L2;
(1.m+16.0)  (1.m+16.n+12)  MAC3 = L3;
```

Referenced registers:

Modified registers:	Data	Control	Data	Control
0	VX0.VY0	R11.R12	0	VX0.VY0
1	VZ0	R13.R21	1	VZ0
2	VX1.VY1	R22.R23	2	VX1.VY1
3	VZ1	R31.R32	3	VZ1
4	VX2.VY2	R33.	4	VX2.VY2
5	VZ2	TRX	5	VZ2
6	RGB_CODE	TRY	6	RGB_CODE
7	OTZ	TRZ	7	OTZ
8	IR0	L11.L12	8	IR0
9	IR1	L13.L21	9	IR1
10	IR2	L22.L23	10	IR2
11	IR3	L31.L32	11	IR3
12	SX0.SY0	L33.	12	SX0.SY0
13	SX1.SY1	RBK	13	SX1.SY1
14	SX2.SY2	QBK	14	SX2.SY2
15	SX2P.SY2P	BBK	15	SX2P.SY2P
16	SZx(0)	LR1.LR2	16	SZx(0)
17	SZ0(1)	LR3.LQ1	17	SZ0(1)
18	SZ1(2)	LQ2.LQ3	18	SZ1(2)
19	SZ2(3)	LB1.LB2	19	SZ2(3)
20	RO.Q0.B0	LB3.	20	RO.Q0.B0
21	R1.Q1.B1	RFC	21	R1.Q1.B1
22	R2.Q2.B2	GFC	22	R2.Q2.B2
23	BFC	BFC	23	BFC
24	MAC0	OFX	24	MAC0
25	MAC1	OPY	25	MAC1
26	MAC2	H.	26	MAC2
27	MAC3	DQA.	27	MAC3
28	IRGB	DQB	28	IRGB
29	ORGb	ZSF3.	29	ORGb
30	DATA32	ZSF4.	30	DATA32
31	LZC	FLAG	31	LZC

Function: Z-averaging

Function: Z-averaging

Calculations:

$$(1.31.21) \quad 00TZ = ZSF3^*SZ0(1)$$

$$(100.11) \quad \text{ZSF3} = 20.9 \text{ GPa} \quad + \text{ZSF3}^* \text{S21(2)}$$

$$\begin{array}{l}
 (0.16, 0) \\
 (1.31, 0)
 \end{array}
 \begin{array}{l}
 \text{OTZ} = \lim_{\epsilon \rightarrow 0} \text{OTZ} \\
 \text{MAC0} = \underline{\text{OTZ}}
 \end{array}$$

2(3); <4>

Register Address	Register Name	Description
0	VX0.VY0	R11.R12
1	VZ0	R13.R21
2	VX1.VY1	R22.R23
3	VZ1	R31.R32
4	VX2.VY2	R33.
5	VZ2	TRX
6	RGB CODE	TRY
7	OTZ	TRZ
8	IR0	L11.L12
9	IR1	L13.L21
10	IR2	L22.L23
11	IR3	L31.L32
12	SX0.SY0	L33.
13	SX1.SY1	RBK
14	SX2.SY2	GBK
15	SX2P.SY2P	BBK
16	SZ1(0)	LR1.LR2
17	SZ0(1)	LR3.LG1
18	SZ1(2)	LQ2.LQ3
19	SZ2(3)	LB1.LB2
20	RO.G0.B0	LB3.
21	R1.G1.B1	RFC
22	R2.G2.B2	GFC
23		BFC
24	MAC0	OFX
25	MAC1	OPY
26	MAC2	H.
27	MAC3	DQA.
28	IRQB	DQB
29	ORQB	ZSF3.
30	DATA32	ZSF4.
31	LZC	FLAG

Module/Interface	Data	Control
0	VX0,VY0	R11,R12
1	VZ0	R13,R21
2	VX1,VY1	R22,R23
3	VZ1	R31,R32
4	VX2,VY2	R33,
5	VZ2	TRX
6	RAB CODE	TRY
7	ORZ	TRZ
8	IR0	L11,L12
9	IR1	L13,L21
10	IR2	L22,L23
11	IR3	L31,L32
12	SX0,SY0	L33,
13	SX1,SY1	RBK
14	SX2,SY2	GBK
15	SX2P,SY2P	BBK
16	SZx(0)	LR1,LR2
17	SZ0(1)	LR3,LG1
18	SZ1(2)	LQ2,LQ3
19	SZ2(3)	LB1,LB2
20	R0 G0 B0	LB3,
21	R1 Q1 B1	RFC
22	R2 Q2 B2	GFC
23		BFC
24	MAC0	OFX
25	MAC1	OPV
26	MAC2	H,
27	MAC3	DQA,
28	IRGB	DQB
29	ORGB	ZSF3,
30	DATA32	ZSF4,
31	LZC	FLAG

AVS24 Required cycles: 6

Function: Z-averaging

Calculations:

(1.31.12) $QQTZ = ZSF4^*SZx(0)$
 $+ ZSF4^*SZ1(2)$
 $+ ZSF4^*SZ2(3); <4>$
 $(0.16, 0) OTZ = \text{ImC}(QQTZ);$
 $(1.31, 0) MAC0 = QQTZ;$

Referenced registers:

	Data	Control	Data	Control
0	VX0.VY0	R11.R12	0	VX0.VY0
1	VZ0	R13.R21	1	VZ0
2	VX1.VY1	R22.R23	2	VX1.VY1
3	VZ1	R31.R32	3	VZ1
4	VX2.VY2	R33.	4	VX2.VY2
5	VZ2	TRX	5	VZ2
6	RGB CODE	TRY	6	RGB CODE
7	OTZ	TRZ	7	OTZ
8	IR0	L11.L12	8	IR0
9	IR1	L13.L21	9	IR1
10	IR2	L22.L23	10	IR2
11	IR3	L31.L32	11	IR3
12	SX0.SY0	L33.	12	SX0.SY0
13	SX1.SY1	RBK	13	SX1.SY1
14	SX2.SY2	QBK	14	SX2.SY2
15	SX2P.SY2P	BBK	15	SX2P.SY2P
16	S2X(0)	LR1.LR2	16	S2x(0)
17	S20(1)	LR3.LQ1	17	S20(1)
18	S2(1)(2)	LQ2.LQ3	18	S2(1)(2)
19	S22(3)	LB1.LB2	19	S22(3)
20	R0 G0 B0	LB3.	20	R0 G0 B0
21	R1 G1 B1	REC	21	R1 G1 B1
22	R2 G2 B2	GFC	22	R2 G2 B2
23		BFC	23	BFC
24	MAC0	OFX	24	MAC0
25	MAC1	OPY	25	MAC1
26	MAC2	H.	26	MAC2
27	MAC3	DQA.	27	MAC3
28	IRGB	DQB	28	IRGB
29	ORGB	ZSF3.	29	ORGB
30	DATA32	ZSF4.	30	DATA32
31	LZC	FLAG	31	LZC

Modified registers:

	Data	Control
0	VX0.VY0	R11.R12
1	VZ0	R13.R21
2	VX1.VY1	R22.R23
3	VZ1	R31.R32
4	VX2.VY2	R33.
5	VZ2	TRX
6	RGB CODE	TRY
7	OTZ	TRZ
8	IR0	L11.L12
9	IR1	L13.L21
10	IR2	L22.L23
11	IR3	L31.L32
12	SX0.SY0	L33.
13	SX1.SY1	RBK
14	SX2.SY2	QBK
15	SX2P.SY2P	BBK
16	S2X(0)	LR1.LR2
17	S20(1)	LR3.LQ1
18	S2(1)(2)	LQ2.LQ3
19	S22(3)	LB1.LB2
20	R0 G0 B0	LB3.
21	R1 G1 B1	REC
22	R2 G2 B2	GFC
23		BFC
24	MAC0	OFX
25	MAC1	OPY
26	MAC2	H.
27	MAC3	DQA.
28	IRGB	DQB
29	ORGB	ZSF3.
30	DATA32	ZSF4.
31	LZC	FLAG

NCLIP

Referenced registers:

	Data	Control
0	VX0.VY0	R11.R12
1	VZ0	R13.R21
2	VX1.VY1	R22.R23
3	VZ1	R31.R32
4	VX2.VY2	R33.
5	VZ2	TRX
6	RQB CODE	TRY
7	OTZ	TRZ
8	IR0	L11.L12
9	IR1	L13.L21
10	IR2	L22.L23
11	IR3	L31.L32
12	SX0.SY0	L33.
13	SX1.SY1	RBK
14	SX2.SY2	QBK
15	SX2P.SY2P	BBK
16	SZx(0)	LR1.LR2
17	SZ0(1)	LR3.LQ1
18	SZ1(2)	LQ2.LQ3
19	SZ2(3)	LB1.LB2
20	R0.Q0.B0	LB3.
21	R1.Q1.B1	RFC
22	R2.Q2.B2	QFC
23	BFC	
24	MAC0	OFX
25	MAC1	OPY
26	MAC2	H.
27	MAC3	DQA.
28	IRQB	DQB
29	ORQB	ZSF3.
30	DATA32	ZSF4.
31	LZC	FLAG

Modified registers:

	Data	Control
0	VX0.VY0	R11.R12
1	VZ0	R13.R21
2	VX1.VY1	R22.R23
3	VZ1	R31.R32
4	VX2.VY2	R33.
5	VZ2	TRX
6	RQB CODE	TRY
7	OTZ	TRZ
8	IR0	L11.L12
9	IR1	L13.L21
10	IR2	L22.L23
11	IR3	L31.L32
12	SX0.SY0	L33.
13	SX1.SY1	RBK
14	SX2.SY2	QBK
15	SX2P.SY2P	BBK
16	SZx(0)	LR1.LR2
17	SZ0(1)	LR3.LQ1
18	SZ1(2)	LQ2.LQ3
19	SZ2(3)	LB1.LB2
20	R0.Q0.B0	LB3.
21	R1.Q1.B1	RFC
22	R2.Q2.B2	QFC
23	BFC	
24	MAC0	OFX
25	MAC1	OPY
26	MAC2	H.
27	MAC3	DQA.
28	IRQB	DQB
29	ORQB	ZSF3.
30	DATA32	ZSF4.
31	LZC	FLAG

QP sf

Required cycles: 6

Function: Outer product

Items specified using arguments:

Argument	Specified content	Value = 0	Value = 1
sf	Output format	-	Performs calculations on data shifted 12 bits to the left in the IRn register.

Calculations: : (m and n request the data format of IRp(p-1,2,3), as

(1.m.n.)
sf == 0 sf == 1
(1.m+28.n) (1.m+16.n+12) **QPX** = DY1(R22)*DZ2(IR3)
 - DZ1(R33)*DY2(IR2); <1>
(1.m+28.n) (1.m+16.n+12) **QPY** = DZ1(R33)*DX2(IR1)
 - DX1(R11)*DZ2(IR3); <2>
(1.m+28.n) (1.m+16.n+12) **QPZ** = DX1(R11)*DY2(IR2)
 - DY1(R22)*DX2(IR1); <3>
(1.m .n) (1.m .n) IR1 = ImA1S(QPX);
(1.m .n) (1.m .n) IR2 = ImA2S(QPY);
(1.m+16.n) (1.m+16.n) IR3 = ImA3S(QPZ);
(1.m+16.n) (1.m+16.n) **MAC1** = QPX;
(1.m+16.n) (1.m+16.n) **MAC2** = QPY;
(1.m+16.n) (1.m+16.n) **MAC3** = QPZ;

Referenced registers:

Referenced registers:		Modified registers:	
		Data	Control
0	YX0.VY0	R11.R12	
1	VZ0	R13.R21	
2	VX1.VY1	R22.R23	
3	VZ1	R31.R32	
4	VX2.VY2	R33,	
5	VZ2	TRX	
6	RGB CODE	TRY	
7	OTZ	TRZ	
8	IR0	L11.L12	
9	IR1	L13.L21	
10	IR2	L22.L23	
11	IR3	L31.L32	
12	SX0.SY0	L33,	
13	SX1.SY1	RBK	
14	SX2.SY2	QBK	
15	SX2P.SY2P	BBK	
16	SZx(0)	LR1.LR2	
17	SZ0(1)	LR3.LQ1	
18	SZ1(2)	LQ2.LQ3	
19	SZ2(3)	LB1.LB2	
20	RO Q0 B0	LB3,	
21	R1 Q1 B1	RFC	
22	R2 Q2 B2	QFC	
23	BFC	BFC	
24	MAC0	OFX	
25	MAC1	OPY	
26	MAC2	H,	
27	MAC3	DQA,	
28	IRGB	DQB	
29	ORG	ZSF3,	
30	DATA32	ZSF4,	
31	LZC	FLAG	FLAG

GPL sf

Required cycles: 5

Function: General purpose interpolation

Items specified using arguments:

Argument	Specified content	Value = 0	Value = 1
sf	Output format	-	Performs calculations on data shifted 12 bits to the left in the IRn register.

Calculations: : (m and n request the data format of IP(p-1,2,3) as (1.m.n))

```

sf == 0      sf == 1
(1.m+28.n)  (1.m+16.n+12)    IPX = MAC1 + IR0*IR1; <1>
(1.m+28.n)  (1.m+16.n+12)    IPY = MAC2 + IR0*IR2; <2>
(1.m+28.n)  (1.m+16.n+12)    IPZ = MAC3 + IR0*IR3; <3>
(1.m .n)    (1.m .n )       IR1 = limA1S(IPX);
(1.m .n)    (1.m .n )       IR2 = limA2S(IPY);
(1.m .n)    (1.m .n )       IR3 = limA3S(IPZ);
(1.m+16.n)  (1.m+16.n )     MAC1 = IPX;
(1.m+16.n)  (1.m+16.n )     MAC2 = IPY;
(1.m+16.n)  (1.m+16.n )     MAC3 = IPZ;
(1.8 .)     (1.8 .)         CD0 <- CD1 <- CODE
(0. 0 .8)   R0 <- R1 <- R2 <- limB1(IPX);
(0. 0 .8)   G0 <- G1 <- G2 <- limB2(IPY);
(0. 0 .8)   B0 <- B1 <- B2 <- limB3(IPZ);

```

```

(1.8 .)     CD0 <- CD1 <- CODE
(0. 0 .8)   R0 <- R1 <- R2 <- limB1(IPX);
(0. 0 .8)   G0 <- G1 <- G2 <- limB2(IPY);
(0. 0 .8)   B0 <- B1 <- B2 <- limB3(IPZ);

```

Referenced registers:

Modified registers:	
	Control
0	VX0.VY0
1	VZ0
2	VX1.VY1
3	VZ1
4	VX2.VY2
5	VZ2
6	RGB CODE
7	OTZ
8	IR0
9	IR1
10	IR2
11	IR3
12	SX0.SY0
13	SX1.SY1
14	SX2.SY2
15	SX2P.SY2P
16	SZx(0)
17	SZ0(1)
18	SZ1(2)
19	SZ2(3)
20	R0 Q0 B0
21	R1 Q1 B1
22	R2 Q2 B2
23	BFC
24	MAC0 OFX
25	MAC1 OPY
26	MAC2 H.
27	MAC3 DQA.
28	IRGB DCB
29	ORG B ZSF3.
30	DATA32 ZSF4.
31	LZC FLAG

Referenced registers:

Referenced registers:	
	Control
0	L11.R12
1	R13.R21
2	R22.R23
3	R31.R32
4	R33.
5	VZ2
6	RGB CODE
7	TRZ
8	IR0
9	IR1
10	IR2
11	IR3
12	L11.L12
13	L13.L21
14	L22.L23
15	L31.L32
16	L33.
17	SX1.SY1
18	SX2.SY2
19	SZx(0)
20	SR0 B0
21	R1 Q1 B1
22	R2 Q2 B2
23	BFC
24	MAC0 OFX
25	MAC1 OPY
26	MAC2 H.
27	MAC3 DQA.
28	IRGB DCB
29	ORG B ZSF3.
30	DATA32 ZSF4.
31	LZC FLAG





